

## FINAL TECHNICAL REPORT

December 14, 1995



DURIP/ONR Grant No. N00014-95-1-0348

### Title: Instrumentation for Coordinate Metrology

The instrumentation acquired under this grant will support several ongoing and proposed research activities at the Applied Research Laboratory and the College of Engineering at The Pennsylvania State University.

The major research area to be supported by the acquired instrumentation is an effort in tolerance specification and assessment to improve turbomachinery affordability. The instrumentation will enable designers to accurately assess the impact of the as-built dimensions of prototype turbomachinery on performance. Other research efforts the equipment will support includes statistical tolerance evaluation, off-line programming, and inspection planning.

The following instrumentation was purchased under this grant:

Equipment: RS-50 Apollo II Coordinate Measuring Machine (CMM)

Manufacturer: Giddings and Lewis

Cost: \$155,152

Equipment: INDIGO2 XZ Graphics Workstation

Manufacturer: Silicon Graphics Computer Systems

Cost: \$23,470

Equipment: Cimstation Inspection

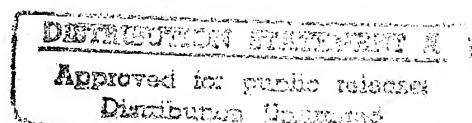
Manufacturer: Silma, Inc.

Cost: \$9,750

Equipment: Zeiss U-Soft CNC Coordinate Measuring Machine Upgrade

Manufacturer: Carl Zeiss

Cost: \$29,850



There were special circumstances which required a change from the proposal upon which this grant was made. In doing the review of CMMs prior to purchase, we found that we were unable to adequately do path planning for inspection of turbomachinery using software provided with the CMMs. The planning of collision-free access of the 5 axis probe is very difficult, and collisions can easily ruin the CMM probe. This path planning is instrumental to the research described in the original proposal. To address this problem, we evaluated several off-line graphical programming tools which enable paths to be generated and checked in a simulated environment, prior to running them on the CMM. This type of software needs to be run on a graphical type workstation computer. With the concurrence of the Scientific Officer and the approval of the

19951219 054

Administrative Grants Officer, the Cimstation Inspection software and a Silicon Graphics workstation computer were acquired to assist in performing path planning for the CMM.

In addition, some security sensitive inspection work planned for the new CMM in the near future at ARL would likely have made it difficult for students in the Department Industrial Engineering to get free access to the machine. As an alternative, we proposed doing a software upgrade and replacing the probe on an existing CMM in the IE Department laboratory. This CMM, while rather small, will provide a starting point for student research, enabling them to move to the new, larger CMM when research needs dictate and when the new machine is available for use. This change was also approved by the Scientific Officer and the Administrative Grants Officer.

These additional acquisitions of instrumentation were made possible within the Grant and matching funds budget due to saving realized when we were able to make use of a precision rotary table from an old, laser based inspection system the Applied Research Laboratory recently salvaged.

At the date of this report, the following tasks have been accomplished:

- the room for the CMM has been retrofitted, and all utilities and computer network connections have been established.
- the CMM has been delivered, installed, and calibrated.
- the Silicon Graphics workstation and Silma software have been received and are functional.
- the Zeiss upgrade order has been placed.
- Applied Research Laboratory employees are scheduling training sessions on the operation and programming of the CMM.

We expect to be fully functional with the instrumentation within 6 months.

Accession For	
NTIS	CRA&I
DTIC	TAB
Unannounced	
Justification _____	
By _____	
Distribution / _____	
Availability Codes	
Dist	Avail and / or Special
A-1	

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.			
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED	
	12/14/95	Final Technical Report 12/94 - 11/95	
4. TITLE AND SUBTITLE		5. FUNDING NUMBERS	
Instrumentation for Coordinate Metrology		Grant No. N00014-95-1-0348	
6. AUTHOR(S)			
Mark T. Traband			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)		8. PERFORMING ORGANIZATION REPORT NUMBER	
The Pennsylvania State University Office of Sponsored Programs 110 Technology Center Building University Park, PA 16802-7000			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
Office of Naval Research Ballston Tower One 800 N. Quincy Street Arlington, VA 22217-5660			
11. SUPPLEMENTARY NOTES			
N/A			
12a. DISTRIBUTION/AVAILABILITY STATEMENT		12b. DISTRIBUTION CODE	
Unlimited			
13. ABSTRACT (Maximum 200 words)			
This report describes instrumentation acquired by The Pennsylvania State University under a Defense University Research Instrumentation Program (DURIP) grant. The instrumentation will support several research programs in the area of coordinate metrology.			
14. SUBJECT TERMS		15. NUMBER OF PAGES	
Inspection, Coordinate Measurement, Metrology		2	
		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unclassified

NSN 7540-01-280-5500

 Standard Form 298 (Rev. 2-89)  
 Prescribed by ANSI Std. Z39-18  
 298-102

**GENERAL INSTRUCTIONS FOR COMPLETING SF 298**

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to *stay within the lines* to meet *optical scanning requirements*.

**Block 1. Agency Use Only (Leave blank).**

**Block 2. Report Date.** Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

**Block 3. Type of Report and Dates Covered.**

State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

**Block 4. Title and Subtitle.** A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

**Block 5. Funding Numbers.** To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C - Contract	PR - Project
G - Grant	TA - Task
PE - Program Element	WU - Work Unit
	Accession No.

**Block 6. Author(s).** Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

**Block 7. Performing Organization Name(s) and Address(es).** Self-explanatory.

**Block 8. Performing Organization Report Number.** Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

**Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es).** Self-explanatory.

**Block 10. Sponsoring/Monitoring Agency Report Number. (If known)**

**Block 11. Supplementary Notes.** Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

**Block 12a. Distribution/Availability Statement.**

Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

**DOD** - See DoDD 5230.24, "Distribution Statements on Technical Documents."

**DOE** - See authorities.

**NASA** - See Handbook NHB 2200.2.

**NTIS** - Leave blank.

**Block 12b. Distribution Code.**

**DOD** - Leave blank.

**DOE** - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.

**NASA** - Leave blank.

**NTIS** - Leave blank.

**Block 13. Abstract.** Include a brief (*Maximum 200 words*) factual summary of the most significant information contained in the report.

**Block 14. Subject Terms.** Keywords or phrases identifying major subjects in the report.

**Block 15. Number of Pages.** Enter the total number of pages.

**Block 16. Price Code.** Enter appropriate price code (*NTIS only*).

**Blocks 17. - 19. Security Classifications.** Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

**Block 20. Limitation of Abstract.** This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.